

Energy (chapter 11)

recall:

Work is a force acting through a displacement
 $W = Fd$, Work is also a change in energy.

$W = \Delta \text{Energy}$ - work energy theorem

We can use this idea to derive equations for energy.

Types of energy:

Thermal energy (energy of motion of particles)

Potential energy - is a big umbrella term for many other types of energy that can be stored

Kinetic energy - energy of motion

Solar energy - consists of electromagnetic radiation (light, x-rays, infrared) and particles

Nuclear energy - energy stored in nucleus, released when some mass turns into energy

$E = mc^2$

Electricity and magnetism

Let's derive an equation for kinetic energy:

What causes changes in motion? Unbalanced forces cause objects to accelerate - change their

motion.

big idea:

work done by the net force causes changes in kinetic energy, E_k (some books KE)

$$W_{\text{net}} = \Delta E_k$$

$$W_{\text{net}} = F_{\text{net}}d \quad \text{but } F_{\text{net}} = ma$$

$= mad$ remember from kinematics

$$v_f^2 = v_i^2 + 2ad \quad \text{or} \quad ad = \frac{1}{2} (v_f^2 - v_i^2)$$

$$W_{\text{net}} = \Delta E_k = m \left(\frac{1}{2} (v_f^2 - v_i^2) \right) = \underbrace{\frac{1}{2} m v_f^2}_{E_{kf}} - \underbrace{\frac{1}{2} m v_i^2}_{E_{ki}}$$

$$E_k = \frac{1}{2} m v^2$$

kinetic energy is a scalar (unlike momentum)

units of Joules, $J = Nm$

eg. a 0.45kg baseball is moving at 10.0 m/s

what is the

- kinetic energy of the baseball?
- momentum of the baseball?
- work done stopping the ball?
- if you stop it over 0.10m, what was the average

force on the ball?

a) $E_k = \frac{1}{2}mv^2 = 0.5 \times (0.45\text{kg})(10.0\text{m/s})^2$

$0.5 \times 0.45 \times 10^2 = 22.5 \text{ kg m}^2/\text{s}^2$

$\text{kgm}/\text{s}^2 = \text{N}$ so $\text{kgm}^2/\text{s}^2 = \text{Nm} = \text{J}$

22.5J of kinetic energy

b) $p = mv = 0.45 \times 10 = 4.5 \text{ kgm/s}$

c) $W = \text{change in energy} = E_f - E_i = 0 - 22.5\text{J}$

$W = -22.5\text{J}$

d) $W = Fd$ $F = W/d = -22.5\text{J}/0.1\text{m} = -225\text{N}$

p221-222 Q1-4 in addition to the previous problems

p210-211 Q13-16 CR 2.1-2.4

Hand in the lab sheet start of next class